1958

Predicting success in the aviation core area at Des Moines Technical High School

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PREDICTING SUCCESS IN THE AVIATION CORE AREA AT DES MOINES TECHNICAL HIGH SCHOOL

by

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A Thesis Submitted to the
Graduate Faculty in Partial Fulfillment of
The Requirements for the Degree of
MASTER OF SCIENCE

Major Subject: Industrial Education

Iowa State College
1958

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I. INTRODUCTION

The rapid advancement in aviation the past few years has created an urgent demand for trained personnel to maintain and service all types of aircraft. National Defense needs, coupled with expanding commercial air transportation, has resulted in a critical shortage of aviation mechanics.

The aviation core area at Des Moines Technical High School serves two purposes. First it was established as a part of an accredited high school program leading to high school graduation. Second, the aviation core area is one of sixty high school programs in the United States that is licensed by the Civil Aeronautics Association for the training of aviation engine mechanics.

Student interest in aviation has been high, due to the publicity, demand, and high pay. The number of students applying for admission in the aviation core area far exceeds the available facilities. Predictive measures are needed for selecting trainees that will be successful.

The purpose of this study was to determine the predictive value of various measures in the aviation core area at Des Moines Technical High School.

The criterion used in predicting success was high school graduation.

The various measures used as variables were:

1. The American Council on Education Psychological Examination, Linguistic, Quantitative, and total score,
2. The Bennett Test of Mechanical Comprehension Test score,
3. The Revised Minnesota Paper Form Board Test score,
4. The 10-B Trade and Industrial orientation course final grade.

II. REVIEW OF LITERATURE

Greater emphasis has been placed on the importance and use of tests and testing in recent years. Schools, colleges and industry have been using tests to assist in selection, placement and guidance of personnel. Intelligence tests were first used and later other tests were designed and developed to measure achievement, aptitude, personality and interest. For prediction purposes, tests must be selected that will accurately measure the characteristics or factors that will predict success. Prediction studies have been included that were closely related to this problem.

Curde[1] attempted to predict achievement in the trade and industrial orientation course for students entering Des Moines Technical High School. The study was designed to determine the value of the American Council on Education Psychological Examination, the Revised Minnesota Paper Form Board Test, the Bennett test of Mechanical Comprehension, and final marks in English. He found in his analysis that all four variables yielded a correlation of .4371 while a correlation of -.42219 was obtained by using only the Revised Minnesota Paper Form Board test. The negative correlation resulted from the reverse order of values assigned to grades. Curde concluded that the Minnesota Paper Form Board test when used alone, could predict achievement as well as when combined with the American Council on Education Psychological examination, the Bennett Test of Mechanical

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[1]Curde, Ted W. Predicting Achievement in the Trade and Industrial Orientation Course at Des Moines Technical High School. Unpublished M. S. Thesis. Ames, Iowa, Iowa State College Library. 1951.

Comprehension, and English marks.

Fribourgh[1] attempted to predict achievement in the first semester of machine shop, printing, auto-diesel and aviation engine courses at Des Moines Technical High School. The Revised Minnesota Paper Form Board Test, the Bennett Test of Mechanical Comprehension, the American Council on Education Psychological Examination, and the trade and industrial orientation shop marks were used as variables. Fribourgh found that the trade and industrial orientation shop marks, with a correlation of .3181 would predict achievement in the machine shop core area. In the printing core area, the best combination of variables for predicting achievement was the Revised Minnesota Paper Form Board Test score and the trade and industrial orientation shop marks with a multiple coefficient of correlation of .6249.

In the auto-diesel core area, the trade and industry orientation marks, with a correlation of .3766, would predict achievement as well as the four variables combined. Fribourgh concluded that either the Bennett Test of Mechanical Comprehension with a correlation of .3963, or the American Council on Education Psychological Examination with a correlation of .3872, would predict achievement in the aviation engine course as well as the two combined.

Harger[2], in a study of 387 ninth grade students in Fort Dodge Junior

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[1]Fribourgh, Gunder F. Predicting Achievement in Machine Shop, Printing, Auto-Diesel and Aviation Engine Courses at Des Moines Technical High School. Unpublished M. S. Thesis. Ames, Iowa, Iowa State College Library. 1952.

[2]Harger, Robert D. Prediction of the Tendency of Fort Dodge Junior High School Students to Matriculate in College. Unpublished M. S. Thesis. Ames, Iowa, Iowa State College Library. 1952.

High School, used the intelligence quotient from the Otis Self-Administering test and the ninth grade mark average as variables in attempting to predict the tendency of Fort Dodge Junior High School students to matriculate in college. Harger found a triserial coefficient of correlation of .422 for the ninth grade mark average and a correlation of .3157 for the intelligence quotient and that both of these values were highly significant. A combination of intelligence quotient and ninth grade mark average as prediction variables yielded a multiple triserial correlation of .4513 which was significant at the one per cent level.

Lathrop[1] attempted to predict success in beginning high school printing at the Ottumwa High School. The three criteria of printing achievement used in this study were grades on written tests, grades on speed tests and grades on projects. The variables used were Intelligence Quotient scores on the Otis test of Mental Ability, scores on the Bennett Mechanical Aptitude Test, scores on the Minnesota Paper Form Board Test, scores on the O'Conner Finger Dexterity Test and scores on the O'Conner Tweezer Dexterity Test. Statistical methods used were Pearson product moment correlation, quadriserial and quintiserial correlation, and discriminant analysis. Lathrop found that the best single prediction of achievement for the three criteria was the O'Conner Finger Dexterity Test. The scores on the Minnesota Paper Form Board Test, the O'Conner Tweezer Dexterity Test, and the I. Q. scores on the Otis Test of Mental Ability were useful when used in combination with the O'Conner Finger Dexterity

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[1]Lathrop, Irvin Tunis. Predicting Success in Beginning High School Printing. Unpublished M. S. Thesis. Ames, Iowa, Iowa State College Library. 1954.

Test. The Bennett Mechanical Aptitude Test could not be used in predicting achievement.

Lathrop[1] attempted to predict achievement in auto-diesel cabinet making, machine shop and printing core areas at Des Moines Technical High School. The five variables used were the American Council on Educational Psychological Examination (total score), the Lee-Thorpe Occupational Interest Inventory (mechanical and scientific scores), the Minnesota Paper Form Board score and the ninth grade mark average. Lathrop concluded that the only variable to be consistent in predictive ability in all four core areas was the ninth grade mark averages. The two parts of the Lee-Thorpe Occupational Interest Inventory were of little or no value for predicting academic success in the four core areas. The Minnesota Paper Form Board and the American Council on Education Psychological Examination were of some predictive values in certain core areas.

Aylsworth[2] attempted to predict achievement in industrial education courses at Iowa State College. The variables used were the high school mark average, American Council on Education Psychological Examination score, Owens-Bennett Test of Mechanical Comprehension score, and Kuder Preference Record Mechanical score. Aylsworth concluded that the variables used were not satisfactory predictors of laboratory achievement. The high school mark average was the only variable to have predictive

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[1]Lathrop, Robert Lee. Predicting Achievement at Des Moines Technical High School in Selected Core Areas. Unpublished M. S. Thesis. Ames, Iowa, Iowa State College Library. 1954.

[2]Aylsworth, William Kenneth. Predicting Achievement in Industrial Education at Iowa State College. Unpublished M. S. Thesis. Ames, Iowa, Iowa State College Library. 1955.

value in nonlaboratory achievement.

Ramey[1] conducted a study to determine the usefulness of the Lee-Thorpe Occupational Interest Inventory for predicting achievement and choice of core areas in the Des Moines Technical School. The variables used were scores from the American Council on Education Psychological Examination, the Revised Minnesota Paper Form Board Test, the Lee-Thorpe Occupational Interest Inventory Test. The core areas were divided into two groups, the mechanical and non-mechanical. The criterion used was the senior core area average marks. Ramey concluded that the prediction of achievement from the information used in the study was impractical. The natural and mechanical interest variables of the Lee-Thorpe Occupational Interest Inventory were found to be useful when both were used for predicting possible selection of core area curriculum.

The foregoing literature dealt with studies that used various measures to predict achievement or success. Four of the studies were previously made at the Des Moines Technical High School, the latest one being completed in 1955.

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[1]Ramey, Walter Scott. Usefulness of the Lee Thorpe Occupational Interest Inventory for Predicting Achievement and Choice of Core Areas in Des Moines Technical School. Unpublished M. S. Thesis. Ames, Iowa, Iowa State College Library. 1955.

III. DESCRIPTION OF AVIATION CORE AREA

The Aviation Core Area was established at Des Moines Technical High School to meet the needs of the students and the community. It serves a dual role, first it is a part of the program leading to high school graduation and second is approved by the Civil Aeronautics Association for the training of aviation engine mechanics. A student must achieve a grade of seventy per cent in all required core area courses before he can be recommended to the Civil Aeronautics Association for examination.

In addition to the regular courses required for high school graduation, these special courses must be included: two semesters of science, mathematics through algebra, one semester of mechanical drawing, the 10-B trades and industrial orientation course and one semester of Vocational Aviation Mechanics related (VAM R-1).

The aviation core area consists of two programs, the study of aircraft engines in the first two semesters, (VAE 1 and 2), and the study of the aircraft airframe in the last three semesters (VAM 1-2-3). Even though the two programs are covered separately, there is actually a continuity throughout the five semesters of work.

The students may enroll for twelve hours of flying, four per semester, for the last three semesters of the program. These are not required, but most of the students participate. The school district pays for one half of the cost of flying instruction which is given by a licensed operator at the Des Moines Municipal Airport.

The first semester, 10-A, (VAE 1), is devoted to basic study of a four stroke, five event, internal combustion engine. A surplus Lycoming,

O-435-T, modified aircraft engine is used for instruction. A typical program covering the study of the engine includes its parts, name and function of each; the lubrication system; ignition system; fuel and carburation system; valve timing etc., each item is covered basically. The students completely disassemble and reassemble the engine.

The VAE 2 is a continuation of engines into the more complex system. An example would be a simple float carburetor into the more complex fuel injection systems. Surplus radial and inline engines are used for laboratory work. The basic systems studied in the first semester are continued to show the relationship of the engine to the airframe itself and the parts of the frame that help the engine perform its task. Accessories of the engine, starters, fuel pumps, generators etc., are studied. The theory of aircraft propellors, maintenance and repair are covered using sample models. Jet theory and practice are covered using surplus jet engines.

In the VAM 1-2-3 courses, the areas are not as defined as for those dealing with the engines. Normally the first semester would include six weeks of a supplemental welding course that emphasizes welding as applied to aircraft structures. Six additional weeks are used for riveting and the remainder of the time on woodwork, fabric and doping. These are basic to the following semesters. Aircraft frame parts are used in welding, riveting and fabric application. Most of the airplanes available for training are still covered with fabric and are the easiest to acquire. The last two semesters are spent in reconditioning aircraft and making them airworthy for CAA approval and for sale. In the final semester the

students participate in the cooperative program by working under actual conditions at the municipal airport.

The related VAM R-1 is used to cover navigation for flying, theory of flight, aircraft instruments, hydraulics, electrical systems in the airframe, and other related subjects.

IV. METHOD OF PROCEDURE

The regular academic courses offered at Des Moines Technical High School are the same as those required by the other high schools accredited by the North Central Association, in addition, the elective courses are vocational. The facilities are limited and the classes are smaller. The relative cost of education was approximately four dollars to one dollar when compared with other high schools in the city.

The students enroll at Des Moines Technical High School after completing the ninth grade work at junior high school. They are classified as a 10-B and must immediately select one of four major areas of vocational training.

The four major areas of vocational training are trades and industry, business occupations, food and clothing trades, and art principles. The Trades and Industrial Orientation course consists of three separate units of work in machine shop, woodworking and basic electricity. It is designed to help the student select a specific core area.

The 10-A students who select the aviation core area are enrolled in Vocational Aviation Mechanics (VAE 1). Class lists kept in the office of the registrar were used and all students enrolled in VAE 1 for the school years 1950 - 51 through first semester 1955-56 were included. Students enrolled during these inclusive dates should have graduated from high school beginning in 1953 through the spring of 1958.

The criterion used in predicting success was high school graduation, or attrition. The permanent records in the graduate and drop files were thoroughly checked for gathering data. A total sample of 196 cases

resulted.

The following cases were not included: 10 students moved out of the city, 2 students were deceased, and complete records were not available on 23. Of the 161 cases remaining, 107 graduated and 54 did not graduate in the aviation core area at Des Moines Technical High School. Statistical treatment of the data collected was necessary to determine the predictive value of the various evaluation measures.

A. Criterion

Success was assumed to be graduation from the aviation core area at Des Moines Technical High School. Students who moved out of the city were not included.

Transfers to other high schools in the city were considered as drop-outs. Any student who was failing or doing poor work was returned to the high school which serves the area in which he resides. Transfers to other core areas within Des Moines Technical High School were also included as drop-outs, since they did not graduate from the aviation core area. The cases remaining were divided into two groups, those who graduated and those failing to graduate.

B. Prediction Variables

The evaluation measures used as variables were as follows:

1. The American Council on Education Psychological Examination

The American Council of Education Psychological Examination hereafter

referred to as A.C.E. is an objective test designed to measure learning ability or scholastic aptitude. The test to be reliable must be properly timed. It is composed of four subtests that are grouped so that two scores differentiate between linguistic ability (L-score), and quantitative thinking (Q-score). The total score (T-score) is an indicator of general scholastic aptitude.

Raw scores were taken from the ninth grade guidance test summaries. All three scores were used as variables, and are referred to as follows:

X_1 - L score

X_2 - Q score

X_3 - T Total score

2. The Bennett Test of Mechanical Comprehension. Form AA

The Bennett Test of Mechanical Comprehension is an aptitude test designed to measure mechanical comprehension or understanding of the relationship of physical forces and mechanical elements in a practical situation. This test is not timed. The test is composed of 60 pictures and questions. The number of correct responses minus one-half the number of wrong items equals the raw score. The raw scores on the Bennett Test of Mechanical Comprehension were used as the X_4 variable.

3. The Revised Minnesota Paper Form Board Test. Series MA

The Minnesota Paper Form Board test consists of 64 problems in special visualization. Each problem has a disassembled figure showing the parts. There are five possible answers and the correct assembled figure

figure must be chosen. It is a 20 minute timed test. The raw score on the Minnesota Paper Form Board Test was designated as the X_5 variable.

4. The 10B Trade and Industrial Orientation Course, final grade

The 10B trade and industrial orientation course was required of all students in the trades and industrial vocational area and carries one-half unit of credit. The semester is divided into three six weeks periods in each of the following shops: (1) woodworking, (2) machine shop, and (3) electricity.

By means of lecture, demonstration and shop work, the basic skills are taught. They are then tested to determine the ability and aptitude of the student. A different instructor teaches each of the three shop courses. The final grade was determined by the three grades received. Failing grades in two areas results in a mark of 5 in the course. The marks assigned are from 1 through 5. The 10B trade and industrial orientation course was used as the X_6 variable.

V. PREDICTING SUCCESS IN THE AVIATION CORE AREA

Success was defined as graduation from the aviation core area at Des Moines Technical High School. The data were collected and summarized as shown in the tables in the appendix. A coefficient of correlation was obtained by first computing a point biserial coefficient of correlation and adjusting the value obtained by a correction factor as outlined by Wert[1].

The formula used to compute the point biserial r was:

$$r_p = \frac{d}{\sigma}\sqrt{pq}$$

where

d = difference between the categories in means of the numerical variable

σ = standard deviation of numerical variable in total group being studied, $\sigma = \sqrt{\frac{\Sigma x^2}{N}}$

p = proportion of cases graduating

q = proportion of cases attritting

The means of the variables and the differences between the means were calculated as shown in Table 1. The present method of screening or selecting trainees prior to enrollment in the aviation core area might account for the small differences found.

Substituting the values for the A.C.E. (L-score) in the formula

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[1]Wert, James E., Neidt, Charles O., and Ahmann, J. Stanley. Statistical Methods in Educational and Psychological Research. New York, Appleton-Century-Crofts, Inc. 1954. pp. 258-277.

Table 1. Means and difference between the means of the numerical variables

Symbol	Graduated		d
	Yes Means	No Means	Difference
$\bar{X}_1$	45.8972	45.2963	.6009
$\bar{X}_2$	19.1495	20.1481	-.9986
$\bar{X}_3$	64.8785	65.1296	-.2511
$\bar{X}_4$	38.7196	36.5926	2.1270
$\bar{X}_5$	42.1215	40.0556	2.0659
$\bar{X}_6$	2.6822	3.2222	-.5400

$$r_p = \frac{.6009}{15.30}\sqrt{(.6646)(.3354)}$$

r_p = .0185 unadjusted r_p = .0232 adjusted

Substituting the values for the A.C.E. (Q-score) in the formula

$$r_p = \frac{-.9986}{5.83}\sqrt{(.6646)(.3354)}$$

r_p = -.0809 unadjusted r_p = -.1013 adjusted

Substituting the values for the A.C.E. (Total score) in the formula

$$r_p = \frac{-.2511}{19.41}\sqrt{(.6646)(.3354)}$$

r_p = -.06108 unadjusted r_p = -.0765 adjusted

Substituting the values for the Bennett Test of Mechanical Comprehension in the formula

$$r_p = \frac{2.127}{8.33} \sqrt{(.6646)(.3354)}$$

r_p = .1206 unadjusted r_p = .1507 adjusted

Substituting the values for the Revised Minnesota Paper Form Board Test in the formula

$$r_p = \frac{2.066}{8.08} \sqrt{(.6646)(.3354)}$$

r_p = .1207 unadjusted r_p = .1509 adjusted

Substituting the values for the final grade received in the 10-B trade and industrial orientation course

$$r_p = \frac{-.540}{.852} \sqrt{(.6646)(.3354)}$$

r_p = -.2992 unadjusted r_p = -.3680 adjusted

To determine if the point biserial coefficients were significantly different from zero, the values obtained were compared with the required values for significance at the one and five per cent levels. It was found that the values for the variable representing the final grade received in the 10-B trade and industrial orientation course exceeded the value necessary for significance at the one per cent level. A negative correlation resulted due to the grading system used, in which one is the highest and five represents a failing grade. The other variables were not significant at the five per cent level.

The relationship between the criterion and one numerical variable was

determined by the use of biserial correlation coefficient. The discriminant equation was then used in predicting a dichotomy.

The coefficients a_1, a_2, a_3, a_4, a_5, and a_6 for the discriminant equation are found by solving the following series of simultaneous equations:

$$Nzd_1 = a_1\Sigma x_1^2 + a_2\Sigma x_1x_2 + a_3\Sigma x_1x_3 + a_4\Sigma x_1x_4 + a_5\Sigma x_1x_5 + a_6\Sigma x_1x_6$$

$$Nzd_2 = a_1\Sigma x_1x_2 + a_2\Sigma x_2^2 + a_3\Sigma x_2x_3 + a_4\Sigma x_2x_4 + a_5\Sigma x_2x_5 + a_6\Sigma x_2x_6$$

$$Nzd_3 = a_1\Sigma x_1x_3 + a_2\Sigma x_2x_3 + a_3\Sigma x_3^2 + a_4\Sigma x_3x_4 + a_5\Sigma x_3x_5 + a_6\Sigma x_3x_6$$

$$Nzd_4 = a_1\Sigma x_1x_4 + a_2\Sigma x_2x_4 + a_3\Sigma x_3x_4 + a_4\Sigma x_4^2 + a_5\Sigma x_4x_5 + a_6\Sigma x_4x_6$$

$$Nzd_5 = a_1\Sigma x_1x_5 + a_2\Sigma x_2x_5 + a_3\Sigma x_3x_5 + a_4\Sigma x_4x_5 + a_5\Sigma x_5^2 + a_6\Sigma x_5x_6$$

$$Nzd_6 = a_1\Sigma x_1x_6 + a_2\Sigma x_2x_6 + a_3\Sigma x_3x_6 + a_4\Sigma x_4x_6 + a_5\Sigma x_5x_6 + a_6\Sigma x_6^2$$

where

N = the number of cases

z = the height of the ordinate at the split p - q

d = the difference in the means of the variables

After substitution of the correct values into the simultaneous equations, they become:

$$35.26197939 = 37688.087a_1 + 7080.7392a_2 + 45177.174a_3 + 7038.3044a_4 + 5609.0000a_5 + 252.300a_6$$

$$-58.60068528 = 7080.7392a_1 + 5478.21119a_2 + 13287.9069a_3 + 2218.5156a_4 + 1927.5715a_5 + 128.65839a_6$$

$$-14.73649729 = 45177.174a_1 + 13287.9069a_2 + 60647.777a_3 + 9098.0373a_4 + 7996.5715a_5 + 315.18013a_6$$

$$124.8184550 = 7038.3044a_1 + 2218.5156a_2 + 9098.0373a_3 + 11212.9938a_4 + 2849.5715a_5 - 171.86335a_6$$

$$121.2333501 = 5609.0000a_1 + 1927.5715a_2 + 7996.5715a_3 + 2849.5715a_4 + 10501.4286a_5 - 19.57142a_6$$

$$-31.68702709 = 252.300a_1 + 128.65839a_2 + 315.18013a_3 - 171.86335a_4 - 19.57142a_5 + 116.993789a_6$$

These equations were solved simultaneously and the following values were obtained:

$a_1 = .005633$

$a_2 = -.01074$

$a_3 = -.003032$

$a_4 = .005548$

$a_5 = .01084$

$a_6 = -.2530$

The per cent of the contribution of each of the six variables to delta was:

Variable	Per cent
A.C.E. (L-score)	1.82
A.C.E. (Q-score)	5.78
A.C.E. (Total score)	.41
Bennett Mechanical	6.35
Minnesota Paper Form Board	12.06
10-B Trade and Industrial Orientation Course	73.58

The multiple point biserial coefficient was obtained by using the following formula:

$$R_p = \left(\frac{\sqrt{pq}}{z}\right) \sqrt{\frac{\Delta}{N}}$$

The appropriate values were substituted in the equation as follows:

$$R_p = \left(\frac{\sqrt{(.6646)(.3354)}}{.36448408}\right) \sqrt{\frac{10.897625172}{161}}$$

$$R_p = .3368$$

Considering the per cent of contribution for each of the variables, a three-variable discriminant equation was used eliminating the first three variables of the A.C.E. test.

The coefficients a_4, a_5, and a_6 are found by solution of the following simultaneous equations:

$$Nzd_4 = a_4\Sigma x_4^2 + a_5\Sigma x_4x_5 + a_6\Sigma x_4x_6$$

$$Nzd_5 = a_4\Sigma x_4x_5 + a_5\Sigma x_5^2 + a_6\Sigma x_5x_6$$

$$Nzd_6 = a_4\Sigma x_4x_6 + a_5\Sigma x_5x_6 + a_6\Sigma x_6^2$$

After substitution of the correct values into the simultaneous equations, they become:

$$124.8184550 = 11212.9938a_4 + 2849.5715a_5 - 171.86335a_6$$

$$121.2333501 = 2849.5715a_4 + 10501.4286a_5 - 19.57142a_6$$

$$-31.68702709 = -171.86335a_4 - 19.57142a_5 + 116.993789a_6$$

These equations were solved simultaneously and the following values were obtained:

$a_4 = .004618399820$

$a_5 = .009802201428$

$a_6 = -.2624194914$

By inserting the appropriate values for the multiple point biserial correlation the formula became:

$$R_p = \left(\frac{\sqrt{(.6646)(.3354)}}{.36448408}\right)\sqrt{\frac{10.08010878}{161}}$$

$$R_p = .3241$$

To determine if a significant loss resulted from eliminating the three A.C.E. scores from the prediction equation, a test of significance was made.

$$F_{n,N-m-1} = \frac{(\Delta_m - \Delta_{m-n})(N-m-1)}{\left(\frac{Nz^2}{pq} - \Delta_m\right)n}$$

where m = the number of variables

n = the number of variables eliminated.

After substitution the formula became:

$$F_{3,154} = \frac{[(10.89762517)-(10.08010878)]\ [161-6-1]}{[(161)(.5962) - (10.08010878)]\ 3}$$

$$F_{3,154} = .4931$$

Examination of the F-table indicates the F value was not significant at the five per cent level. Therefore the first three variables, the three scores from the A.C.E. test, were eliminated without significant loss.

In order to determine if one of the remaining variables could be dropped without significant loss, a new delta was computed and tested after dropping the Bennett Test of Mechanical Comprehension variable. The results obtained were:

$$\Delta = 9.8625$$

$$F_{1,157} = .3977$$

Examination of the F-table indicates the F-value was not significant at the five per cent level. The Bennett Test of Mechanical Comprehension was eliminated without significant loss.

A new delta was computed and tested after the Minnesota Paper Form Board Test variable was dropped. The results obtained were:

$$\Delta = 8.5822$$

$$F_{1,158} = 2.3486$$

Examination of the F-table indicates the F-value was not significant at the five per cent level. The Revised Minnesota Paper Form Board Test was eliminated without significant loss.

The results of the foregoing analyses left only the final grade received on the trade and industrial orientation course as a variable for solution of the discriminant function. The prediction of probability for survival was obtained by the discriminant analysis technique, where the values were substituted in the raw score formula for predicting survival in sigma units.

Raw score form

$$V - \overline{V} = a_6(X - \overline{X})$$

Substituting the coefficient value for a_6, the equation became

$$V - .6646 = -.2708436692(X - 2.68)$$

reduced form

$$V = -.2708436692X + 1.3904$$

When V is computed, a value is obtained, which upon consulting a table of normal curve will yield the probability of graduating. The equation was solved for each of the final grades received in the 10-B trades and industrial orientation course and the probabilities are shown in Table 2.

Table 2. Probability, in per cent, of graduating and attritting based on the final grade received in the 10-B trade and industrial orientation course

Grade	Graduated	
	Yes	No
1	86	14
2	80	20
3	72	28
4	62	38
5	51	49

VI. DISCUSSION

The results of the foregoing analyses left only the final grade received in the trade and industrial orientation course as a predictor of success. The point biserial coefficient of correlation obtained for the course exceeded the value necessary for significance at the one per cent level.

The American Council on Education Psychological Examination, the Bennett Test of Mechanical Comprehension, and the Revised Minnesota Paper Form Board Test proved to be of little or no value for predicting success in the Aviation Core area at Des Moines Technical High School. The small differences in the means between the two groups might possibly be explained by the screening or selecting of trainees prior to their enrollment in the first course. In fact, two small negative values resulted in the differences between the means on the A.C.E. Q-score and total scores. For this sample, the tests of aptitude do not work as prediction variables.

A thorough study to determine the causes for drop-outs might provide additional information that would be helpful for guidance purposes and in the selection of trainees. Reduction of drop-outs is important because of the limited training facilities and the higher cost of vocational training.

Beginning the second semester of 1954, a new series of tests have been added for the 10-B grade level. The first test was the Flanagan Aptitude Classification Tests, divided as follows: 1A - Inspection, 4A - Precision, 5A - Assembly, 10A - Patterns, 11A - Components, and 13A - Mechanics. The second test was the Thurstone Temperament Schedule, designed to measure personality in the following areas: A. Active,

V. Vigorous, I. Impulsive, D. Dominant, E. Stable, S. Sociable, and R. Reflective. The primary aim of the Thurstone Temperament Schedule is to evaluate an individual in terms of his relative permanent temperament traits or personality. Since the existing tests of aptitude do not seem to work as prediction variables, other tests should be tried. As soon as test data are available on enough cases, an interesting informative study can be made.

Counselors and guidance personnel might strongly encourage students who are planning to enter vocational training at Des Moines Technical High School to enroll in the ninth grade shop program at the junior high school. At a later date it might be advisable for a study to be made of the ninth grade shop mark as a predictor of success in the Des Moines Technical High School.

VII. SUMMARY

The purpose of this study was to determine the value of various evaluation measures for prediction of success in the aviation core area at Des Moines Technical High School. The criterion used in predicting success was high school graduation.

The various evaluation measures used as variables were:

1. The American Council on Educational Psychological Examination
   - (L-score) = X_1
   - (Q-score) = X_2
   - (total score) = X_3
2. The Bennett Test of Mechanical Comprehension, test score = X_4
3. The Revised Minnesota Paper Form Board Test, test score = X_5
4. The 10-B Trade and Industrial Orientation, final grade = X_6

The permanent records in the office of the registrar were used in gathering data. All 10-A students enrolled in vocational aviation mechanics (VAE 1) for the school years 1950-1951, through the first semester 1955-1956 were included in the study. This provided information on graduates from 1953 through June 1958. From a total sample of 196 cases, 35 cases were not included. Of the 161 cases remaining, 107 graduated and 54 did not graduate.

A coefficient of correlation was obtained by first computing a point

biserial coefficient of correlation and adjusting the value obtained by a correction factor. It was found that the value for the variable representing the final grade received in the 10-B trade and industrial orientation course exceeded the value necessary for significance at the one per cent level. The other variables were not significant at the five per cent level.

The discriminant equation with six variables was used and solved by substituting the correct values into the simultaneous equation. A multiple point biserial coefficient of correlation yielded a coefficient of .3368.

Considering the per cent of contribution of each of the variables, a three variable discriminant equation was used eliminating the first three variables of the A.C.E. test. A multiple point biserial coefficient of correlation yielded a coefficient of .3241. A test of significance resulted in an F value that was not significant at the five per cent level. The three scores from the A.C.E. were eliminated without loss.

Using the same procedure, the Bennett Test of Mechanical Comprehension and the Revised Minnesota Paper Form Board Test were also eliminated without significant loss.

The results of the foregoing analyses left only the final grade received in the Trade and Industrial Orientation Course as a predictor. The prediction of probability for survival was obtained by the discriminant analysis technique, where the values were substituted in the raw score formula for predicting survival in sigma units (see Table 2).

VIII. LITERATURE CITED

Aylsworth, William Kenneth. Predicting Achievement in Industrial Education at Iowa State College. Unpublished M. S. Thesis. Ames, Iowa, Iowa State College Library. 1955.

Curde, Ted W. Predicting Achievement in the Trade and Industrial Orientation Course at Des Moines Technical High School. Unpublished M. S. Thesis. Ames, Iowa, Iowa State College Library. 1951.

Fribourgh, Gunder F. Predicting Achievement in Machine Shop, Printing, Auto-Diesel and Aviation Engine Courses at Des Moines Technical High School. Unpublished M. S. Thesis. Ames, Iowa, Iowa State College Library. 1952.

Harger, Robert D. Prediction of the Tendency of Fort Dodge Junior High School Students to Matriculate in College. Unpublished M. S. Thesis. Ames, Iowa, Iowa State College Library. 1952.

Lathrop, Irvin Tunis. Predicting Success in Beginning High School Printing. Unpublished M. S. Thesis. Ames, Iowa, Iowa State College Library. 1954.

Lathrop, Robert Lee. Predicting Achievement at Des Moines Technical High School in Selected Core Areas. Unpublished M. S. Thesis. Ames, Iowa, Iowa State College Library. 1954.

Ramey, Walter Scott. Usefulness of the Lee Thorpe Occupational Interest Inventory for Predicting Achievement and Choice of Core Areas in Des Moines Technical School. Unpublished M. S. Thesis. Ames, Iowa, Iowa State College Library. 1955.

Wert, James E., Neidt, Charles O., and Ahmann, J. Stanley. Statistical Methods in Educational and Psychological Research. New York, Appleton-Century-Crofts, Inc. 1954.

IX. APPENDIX

Table 3. Raw score data for graduates in the aviation core area

No.	X_1	X_2	X_3	X_4	X_5	X_6
1	53	26	80	53	47	2
2	31	23	56	16	30	4
3	36	12	45	30	30	3
4	65	16	81	36	42	3
5	53	18	71	35	46	3
6	74	25	99	41	47	3
7	29	22	51	31	24	2
8	57	28	86	46	59	1
9	33	14	45	39	44	3
10	39	20	61	42	53	3
11	47	15	62	39	43	3
12	22	23	64	27	59	3
13	63	9	69	35	36	3
14	57	33	90	53	51	2
15	34	19	52	27	40	3
16	32	13	45	36	31	3
17	42	11	53	39	43	2
18	75	13	88	32	46	3
19	31	16	47	48	49	3
20	37	11	46	33	32	3
21	31	12	41	37	36	3
22	47	21	68	44	44	3
23	66	8	71	30	53	3
24	65	18	73	41	37	2
25	47	18	67	27	38	1
26	56	15	69	21	44	3
27	31	12	41	29	40	5
28	48	16	64	40	26	3
29	34	23	58	33	59	2
30	50	19	68	29	42	3
31	46	16	62	55	47	2
32	28	13	32	39	34	3
33	71	21	91	50	47	3
34	51	18	69	39	27	3
35	35	19	41	39	47	3
36	38	19	58	30	42	3

Table 3. (Continued)

No.	X_1	X_2	X_3	X_4	X_5	X_6
37	54	23	78	43	40	2
38	48	22	71	50	44	3
39	43	16	60	32	37	3
40	56	21	77	35	39	2
41	28	14	41	26	38	3
42	58	23	81	45	47	3
43	43	12	54	47	46	2
44	33	10	43	45	30	2
45	61	15	74	43	60	3
46	21	14	33	36	39	3
47	57	20	77	36	46	3
48	10	10	16	36	30	2
49	48	13	59	33	43	1
50	75	29	104	50	43	5
51	13	11	23	33	33	2
52	43	24	69	36	35	4
53	18	9	25	36	43	3
54	59	14	71	47	44	3
55	70	26	96	55	45	2
56	68	22	91	54	42	2
57	73	23	97	44	30	3
58	37	21	58	18	37	2
59	50	26	76	48	40	3
60	28	14	41	36	50	2
61	66	21	88	34	48	4
62	37	12	48	24	23	3
63	39	11	48	39	51	3
64	28	22	52	27	41	3
65	22	15	36	34	33	4
66	23	23	48	48	46	1
67	46	18	64	33	44	2
68	58	15	71	45	39	3
69	56	27	83	39	44	3
70	30	26	56	33	44	2
71	39	13	51	45	36	2
72	46	19	67	41	45	2

Table 3. (Continued)

No.	X_1	X_2	X_3	X_4	X_5	X_6
73	34	21	56	44	50	3
74	74	35	108	54	47	3
75	13	10	20	41	53	3
76	38	21	61	41	41	2
77	66	28	94	47	45	2
78	52	22	74	48	48	2
79	42	26	71	38	35	3
80	59	9	67	29	47	3
81	43	18	61	44	39	3
82	45	26	73	32	45	3
83	53	30	86	41	39	3
84	42	23	67	50	44	4
85	17	17	33	37	42	2
86	24	11	34	45	46	2
87	47	20	68	44	44	2
88	75	29	104	45	42	2
89	71	20	92	28	39	2
90	66	28	93	50	60	3
91	33	21	54	31	44	3
92	64	18	82	34	51	4
93	59	18	77	48	43	1
94	44	17	61	37	32	2
95	51	26	77	39	37	4
96	56	24	80	34	47	2
97	37	21	58	35	33	3
98	41	22	63	32	52	2
99	40	19	59	29	24	3
100	62	29	91	54	56	2
101	56	23	79	36	41	2
102	31	17	48	33	49	4
103	45	23	68	45	39	3
104	59	22	81	47	42	1
105	69	31	101	45	48	3
106	27	14	41	32	41	2
107	48	21	69	47	32	4

Table 4. Raw score data for non-graduates in the aviation core area

No.	X_1	X_2	X_3	X_4	X_5	X_6
1	54	28	83	33	50	4
2	33	16	48	36	31	2
3	54	25	79	47	33	4
4	44	14	58	44	46	2
5	34	22	57	14	44	4
6	46	21	67	36	44	4
7	50	19	69	38	43	4
8	73	34	105	35	35	3
9	19	12	30	41	28	2
10	10	12	16	40	43	2
11	25	17	42	38	50	3
12	71	23	93	27	50	5
13	57	23	80	50	47	3
14	59	17	74	32	30	3
15	52	19	71	44	42	3
16	60	27	92	42	57	3
17	46	24	70	32	32	3
18	57	28	85	40	45	4
19	23	12	33	28	33	1
20	32	12	44	38	28	3
21	20	13	32	37	17	3
22	34	20	54	29	34	4
23	58	26	84	50	50	5
24	47	25	73	34	50	3
25	79	23	102	34	42	2
26	32	18	50	30	38	2
27	61	22	83	45	38	4
28	52	14	66	42	48	3
29	38	12	50	38	35	3
30	60	18	78	35	33	3
31	51	25	77	50	46	4
32	28	19	48	20	39	3
33	44	13	57	13	43	4

Table 4. (Continued)

No.	X_1	X_2	X_3	X_4	X_5	X_6
34	53	21	74	47	45	4
35	36	27	63	31	18	3
36	40	19	61	27	33	4
37	37	14	51	41	25	3
38	34	20	54	27	44	2
39	48	20	55	41	45	4
40	41	19	60	42	39	3
41	70	17	87	51	47	1
42	37	10	47	28	38	2
43	56	27	83	42	49	4
44	45	15	60	31	50	3
45	32	12	44	38	28	3
46	68	30	98	35	38	4
47	41	17	58	42	43	4
48	46	21	67	44	52	3
49	37	21	58	31	38	4
50	26	20	46	33	37	4
51	49	31	80	41	47	4
52	61	28	89	48	39	3
53	42	22	64	28	46	4
54	44	24	68	36	38	3

Table 5. Values of the prediction variables for the aviation core area

Symbol	Raw scores Graduated Yes	Raw scores Graduated No	Total
N	107	54	161
ΣX_1	4911	2446	7357
ΣX_2	2049	1088	3137
ΣX_3	6942	3517	10459
ΣX_4	4143	1976	6119
ΣX_5	4507	2163	6670
ΣX_6	287	174	461
ΣX_1^2	251693	122178	373871
ΣX_2^2	42959	23642	66601
ΣX_3^2	491642	248451	740093
ΣX_4^2	167755	76018	243773
ΣX_5^2	196357	90473	286830
ΣX_6^2	835	602	1437
ΣX_1X_2	98467	51961	150428
ΣX_1X_3	349512	173596	523108
ΣX_1X_4	195181	91469	286650
ΣX_1X_5	209892	100507	310399
ΣX_1X_6	13251	8067	21318

Table 5. (Continued)

Symbol	Raw scores Graduated Yes	Raw scores Graduated No	Total
ΣX_2X_3	141703	75373	217076
ΣX_2X_4	81233	40211	121444
ΣX_2X_5	87521	44368	131889
ΣX_2X_6	5481	3630	9111
ΣX_3X_4	275614	130991	406605
ΣX_3X_5	297008	144290	441298
ΣX_3X_6	18615	11648	30263
ΣX_4X_5	176565	79786	256351
ΣX_4X_6	10993	6356	17349
ΣX_5X_6	12019	7060	19079

Table 6. Deviation form of squares and cross products

Symbol	Deviation scores
Σx_1^2	37688.087
Σx_2^2	5478.21119
Σx_3^2	60647.777
Σx_4^2	11212.9938
Σx_5^2	10501.4286
Σx_6^2	116.993789
$\Sigma x_1 x_2$	7080.7392
$\Sigma x_1 x_3$	45177.174
$\Sigma x_1 x_4$	7038.3044
$\Sigma x_1 x_5$	5609.00
$\Sigma x_1 x_6$	252.30
$\Sigma x_2 x_3$	13287.9069
$\Sigma x_2 x_4$	2218.5156
$\Sigma x_2 x_5$	1927.5715
$\Sigma x_2 x_6$	128.65839
$\Sigma x_3 x_4$	9098.0373
$\Sigma x_3 x_5$	7996.5715
$\Sigma x_3 x_6$	315.18013
$\Sigma x_4 x_5$	2849.5715
$\Sigma x_4 x_6$	-171.86335
$\Sigma x_5 x_6$	-19.57142